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MEASUREMENT OF PRODUCTIVITY

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Note by the secretariat*

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INTRODUCTION

1. Any discussion on the measurement of national productivity is likely to be rather technical and to sound somewhat academic. But the subject-matter is of profound importance since it is the rising output per man-hour which must yield the ingredients of a rising standard of living. Growth in productivity makes it possible for real wages and real profits to rise side by side. Rapid advance in productivity is the key to stability of the price level as money incomes rise, to fundamental improvement in the balance of international payments and to growth in a nation's capacity to meet the challenges of socio-economic development. Furthermore, since various forms of capital investment constitute the basic source of future gains in productivity, the importance of increases in investment outlays such as on science and technology, plant and equipment, and education and training in achieving accelerated economic growth needs to be emphasized.

I. MEASUREMENT OF PRODUCTIVITY IN PERSPECTIVE

2. In order to place the issues regarding the measurement of productivity in some sort of perspective, two general points should be recalled. First, the development of a sound statistical system is, in a fundamental sense, a grand exercise in co-operation. There are at least three reasons for this: the first reason is that statistical series come into being by rearranging, auditing and analysing the information that the public supplies. Thus, the production of good statistics necessarily involves the willing co-operation and goodwill of those who supply the basic data - individuals, business organizations, government departments, and so on. The second reason is that statistical activity is designed to produce a service which is considered important, useful and which is used. In fact, the demand for statistical information has been increasing with the growing complexity of the economy, competition and the large size of decision-making units, both public and private. The increasing interest in statistics stems from the same factors that are responsible for the growing interest in scientific management and technological improvements. In the last analysis, interest in these matters is sustained by an awareness that attention to them pays off. Thus, co-operation with the users of the data is essential in order to keep abreast of their growing and increasingly relentless needs. The third reason is that a statistical series is seldom used in isolation. As a rule, various aspects of a problem have to be considered before a policy regarding it is

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formulated. The statistics relating to these various aspects must be comparable. The production of comparable statistics necessarily requires that the statisticians co-operate among themselves - there must be an awareness of interdependence.

3. The second general point to be made is that the development of the component parts of an integrated system of national economic intelligence necessarily involves a great deal of research, experimentation, ingenuity and time. There are many reasons for this, of which several need to be mentioned. The economic events and processes the statistics are designed to reflect are seldom simple and static; they are complex and changing. The records kept by firms and individuals of the same events frequently vary and at times are incomplete for statistical purposes. In the course of transmitting statistical requirements to respondents, opportunities for misunderstandings exist. In the ever-present quest to reduce the burden of response, shortcuts are used which, however, produce errors of a varying degree of significance. Last but not least, the science or art of measurement has by no means reached the stage of perfection.

4. These two general points - the reliance on co-operation and the need for research, experimentation and time - apply with particular force to the measurement of productivity. This is because productivity statistics are at the apex of the system of economic statistics. The antecedents, in the form of employment statistics, production statistics, price statistics and so on, have to be there. Incidentally, these antecedents are themselves dependent on the availability of a great number of statistical series. However, these antecedents have not been designed for the particular purpose of measuring productivity and, as a consequence, considerable rearrangement of the data and some adjustment of concepts are involved. Further, for productivity measurement more, or special, detail and a somewhat higher degree of accuracy are often required.

II. THE NATURE OF PRODUCTIVITY MEASUREMENT

5. As is generally realized, the notion conveyed by the word "productivity" centres around the relationship of physical outputs and physical inputs, the outputs representing the economic achievements (in a plant, an industry or the economy) and inputs representing the over-all efforts that have gone into these achievements. In measuring productivity, an attempt is made to match these outputs and inputs in such a way as to make them comparable. The matched outputs and inputs are expressed in the form of a ratio. As a rule, an

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appraisal is made of the effectiveness with which real resources are utilized at any particular time by making comparisons with preceding periods - the preceding month, the preceding year, the preceding decade. It follows that the outputs and inputs must be comparable over time in order to render such comparisons meaningful.

6. If the composition and valuation of output, for example, were simple and unchanging from year to year and differed only in that there were changes in the amount produced, as measured, say, by the number of individual commodities, then it would be easy to construct meaningful output measures. In fact, the composition and valuation of production is complex and subject to change.

7. A concrete example may make these general statements somewhat more meaningful. In Canada, few problems are encountered in measuring the physical output of the gold-mining industry. (Owing to the homogeneity of the product in this industry in most, if not all, gold-producing countries, this statement is probably valid for most such countries.) This industry produces, for the most part, a single product that is homogeneous and has not changed over time; an ounce of gold bullion now is the same as it was in 1939. Accordingly, the change in number of ounces of gold bullion produced between 1939 and the present time is an accurate indication of the change in the volume of output of the gold-mining industry. The situation is entirely different in the case of, say, the agricultural implements industry. As is known, this industry turns out a great variety of agricultural machinery, the characteristics of which have been changing from year to year. Thus, the character of combines has changed substantially in that the conventional large types have been displaced, in recent years, by smaller varieties. A comparison of the total number of units produced has accordingly become a misleading guide to changes in the volume of production of the industry. Further, the quality of its products has improved; in the case of combines, for example, this has taken the form of attachments or built-in features that permit the combines to do a more efficient job than previously. Such changes in quality have to be detected, and, to the extent possible, incorporated in the output measure. Also, new products have appeared, for example, pick-up hay balers; these have gained in relative importance since their introduction in the early 1950s. Such innovations must also be incorporated in the output measure. Moreover, certain changes in the organization of establishments may affect the measured movements of an industry's output.

8. The situation with regard to inputs is no more comforting. Even labour, regarded as the most readily measurable input, is a complex of skills, experience and application that may change over time and varying circumstances. However, these changes probably do not take place as rapidly as in the case of output.

9. It has been said that politics is the art of the possible. One may claim the same for statistics. Various devices have been developed, taking the form mainly of so-called index numbers, which attempt to measure the movements of output and input in such a way as to facilitate comparisons.

10. These devices are, however, based on certain simplifying assumptions about the composition and valuation of output and input that may lead to significant distortions of reality. This fact, together with the imperfections in the available statistics already referred to, imposes a responsibility on the statistician to take steps to ensure that the estimates he recommends for public use are not in fact hazardous booby-traps. The need for precision is particularly great in productivity measurement because year-to-year changes are typically small and can, therefore, be easily matched or exceeded by relatively small errors in the numerator or the denominator of the productivity ratio, and because the data may be used for rather important purposes.

11. The question then arises, how does the statistician avoid getting into the business of producing booby-traps?

12. Apart from intensive analysis of the statistical results and constant probing for "reasonableness", it is considered sound statistical practice to measure a phenomenon, particularly a complex phenomenon, in at least two ways. In addition to providing a check, each way makes available special information. If the two ways provide reasonably similar results, then there is some presumption that either, or an average of the two, is not too far off the mark.

III. A CASE STUDY

13. With this background it may now be useful to look at how the productivity measurement programme was developed in Canada during the early 1960s by the then Dominion Bureau of Statistics (DBS) and the vexing issues it faced at the time. This account, though somewhat old, may provide a useful illustration of issues and problems on which many a developing country of the ESCAP region would need to ponder when they commence their efforts in measuring productivity.

14. The programme of productivity measurement in Canada as it was envisaged in the early 1960s consisted of two parts: first, the measurement of global indexes covering the national economy, with the exception of agriculture and government activity; and secondly, developmental work on indexes for individual industries, mainly in manufacturing. It was planned to extend the indexes back to 1947 wherever possible. Some 15 industries were tentatively selected for this purpose in co-operation with the Department of Labour and other departments. It was anticipated that with the staff available, it would take some three years to carry out the work on these industries. The successful completion of the work would necessarily involve the active co-operation of the major firms. Discussion of conceptual and methodological matters with trade union officials would also be undertaken. It was impossible to say at the outset which indexes, if any, would be suitable for regular publication but it was anticipated that the research work involved would throw much light on the nature of productivity change and measurement in the industries concerned and the nature of productivity analysis in general.

15. For a number of years DBS worked on two, more or less independent, measures of national production in constant dollars. These two measures provided reasonably similar movements over time. While those data needed to be improved further particularly for the portion of the economy producing services rather than commodities, it was felt that they were as adequate for use in over-all productivity measures for the non-farm business sector of the economy as corresponding statistics in any other country.

16. With regard to input, however, DBS was in a less fortunate position. In the first place, it had to confine itself to labour input only, as the DBS work on capital input was in a very primitive stage. There were extremely complex conceptual as well as statistical problems in the measurement of capital stock. In the second place, DBS was compelled to treat all labour input as though it were homogeneous and of unchanging composition over time.

17. In the case of labour input, DBS also attempted to measure the same thing in two different ways. It started out with the two available statistical series on paid (wage and salary) workers (one from the monthly "labour force" survey and the other from the monthly "employment" survey) which, however, did not measure the same thing, even though they had much in common. The movements of those two statistical series had differed considerably in the previous few years and DBS had been exploring the factors responsible for those differences and their quantitative importance. Over a dozen such factors were being explored and the study of several had been completed. For example,
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certain service industries were covered in the labour force series but not in the employment survey; part-time and casual workers were, apparently, covered to a greater extent in the labour force survey than the employment survey; the employment survey was confined to establishments employing 15 persons and over until 1961, when a sample survey of establishments with less than 15 employees was introduced. The adjustments DBS had been able to make up to that time had brought the two series closer together but they still differed by a considerable margin. It was hoped that within a year or so enough would have been learnt about the factors responsible for the remaining difference to enable the production of an acceptable series for productivity purposes. DBS would then have been able to construct an adequate series of production per paid worker. Using available incomplete and largely incompatible statistics on paid workers would have yielded a variety of indexes differing considerably from each other merely for statistical reasons.

18. By adding the number of employers to paid workers DBS got the total number of persons engaged in production. This more comprehensive measure was, from many points of view, the more suitable denominator for the productivity ratio and DBS proceeded to use those data upon their completion in order to calculate productivity indexes on that basis also. Further, the number of hours worked per year by people changed from time to time. A project aiming to produce estimates of the average number of hours worked per year by (a) paid workers and (b) employers was at an advanced stage and DBS planned to use those data to calculate output indexes per man-hours worked.

19. The construction of productivity indexes for individual industries was even more difficult. For one thing there was less opportunity for cancelling errors that came into play. For another, classification issues involving somewhat arbitrary distinctions of one industry from another loomed larger and the precise matching of outputs and inputs became more difficult. For another, there was a greater variety of methods for measuring outputs and frequently they gave results that differed significantly. It was clear that each industry would have to be studied exhaustively and in collaboration with the firms in question in order to determine the most suitable output figure for productivity purposes.

20. The agricultural implements industry was investigated in detail and other industries were gradually added to the productivity statistics development programme. The (gross) output of the agricultural implements industry,

industry, for the year 1947 to 1960, was estimated in two different ways using information from regular DBS surveys - first by deflating the index of gross value of production by a corresponding price index, and secondly, by projecting base-year values of groups of commodities by indexes representing, in the main, the number of units of these commodities that had been produced. The differences in the movement of those two indexes was large. DBS obtained additional information going back to 1956 from some of the firms in the industry. When this information was used the two indexes were brought together significantly. Confidence was felt that if certain additional information were made available to DBS for the whole time-period under study, the differences in movement of the two series would be reduced to insignificant proportions. The movement of labour input indexes for this industry, using two different sources, was reasonably close, but, because of the differences in the output measures referred to, the resulting ratios of output per paid worker differed a great deal.

IV. CONCLUDING REMARKS

21. It would appear from the above that the measurement of productivity is a complex problem and is beset with many difficulties concerning in particular the choice of appropriate indicators of output and input, ensuring comparability of the two series and correlating them to derive acceptable measures of productivity. As the Canadian experience showed, it is only over time that these problems and difficulties can be overcome. In this regard, the co-operation of a large number of individuals and enterprises who are both suppliers and users of productivity information is essential; so is that of trade union research officials. Above all, relevant statistical series need to be continued. Finally and importantly, it has been the experience of DBS that the production on a regular basis of productivity measures and their improvement over time requires a high level of consciousness as to the importance of such statistics by policy level decision makers. In particular, for the successful implementation of such a programme and its maintenance over time, adequate resources must be made available in a flexible manner to statistical authorities in order to enable them to retain their competent staff in that specialized field and to add to them if the need for this is demonstrated.